Electronic Fetal Monitoring: 
*Guidelines for Interpretation*
Kathryn Welch, MD

**Objectives**
- History of fetal monitoring
- Definitions
- Limitations
- Practice

**Introduction**
- Goal of electronic fetal monitoring (EFM) is to detect fetal hypoxia and signal to the clinician that an intervention is needed to correct the oxygen deficiency
- EFM is the most common obstetric procedure
- Use common language to communicate and document findings

**A brief history**
- Fetal heart sounds were first reported in the 1600’s
- In the 1800’s, again described and used to determine viability and fetal lie.

**Fetoscope**
- 1917 David Hillis in Chicago described the fetoscope, but in 1922 Joseph DeLee took the credit!
  - Eventually known as DeLee-Hillis fetoscope
- Concept of intermittent monitoring evolved and became standard of care well into the 1970s

**“Father of EFM”**
- In 1958, Dr. Edward Hon reported fetal ECG from the maternal abdomen.
- Similar achievements were made around the globe
- 1972, Hon invented the fetal scalp electrode
How does it work?

• “FHR results from the signal processor, which counts every R-R interval of the ECG from the scalp electrode, converts this interval to rate, and displays every interval (bpm)”

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EFM Guidelines

CLINICAL OPINION

Electronic fetal heart rate monitoring: Research guidelines for interpretation

Gabbe 2012

EFM Guidelines

• NICHĐ Workshop Research Planning Workshop 1997
  – Objective: to propose a standardized (and unambiguous) set of definitions
  – Goals:
    – more precise interpretation of FHR patterns
    – more evidence-based approach to the management of labor


NICHĐ Guidelines

• Assumptions:
  – Definitions are for visual interpretation of FHR patterns
  – Primarily for intrapartum events, but also applicable to antepartum observations

ACOG PB #106
ACOG PB #106

Breakdown of definitions

- Monitor display
- Normal fetal heart rate tracings
- Contractions tracing

Fetal heart monitor display

The Display

- Each small vertical square is 10 beats
- Each small horizontal square is 10 seconds
- Each large horizontal square is 1 min

Reading EFM

- Baseline
- Variability
- Accelerations
- Decelerations
- Contractions

Baseline

- Mean FHR rounded to increments of 5 bpm during a 10-minute segment
- Excluding:
  - Periodic or episodic changes
  - Periods of marked variability
  - Segments of baseline that differ by more than 25 bpm
- Baseline must be for a minimum of 2 minutes
Normal Baseline

110 – 160 bpm

Where is the baseline?

Variability

Variability = Amplitude

Variability represents fetal CNS and cardiac activity

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Absent</td>
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Williams Obstetrics, 23rd Edition, 2010
Variability
As a rule, moderate variability provides reassurance about fetal status and the absence of metabolic acidemia.

Acceleration
- Visually apparent abrupt increase in the FHR
  - Onset to peak <30 seconds
- Prolonged acceleration lasts 2-10 minutes, longer than 10 minutes is a baseline change

> 32 weeks 15 x 15
< 32 weeks 10 x 10

Reading EFM
- Baseline
- Variability
- Accelerations
- Decelerations (next lecture)
- Contractions

Uterine Contractions
- External tocodynamometer
  - Frequency and duration of contractions
  - Noninvasive but uncomfortable, difficult to monitor obese patients
- Intrauterine pressure catheter
  - Frequency, duration & adequacy of contractions
  - Resting tone between contractions
  - Only when membranes are ruptured; invasive
  - Uncomfortable and limits patient mobility
  - Can be used for intrauterine resuscitation

Contractions
- 10 minute window averaged over a 30 minute period
- Normal: 5 contractions or less in a 10 minute window over a 30 minute window
Uterine contractions

**Contraction Concepts**
- Frequency: beginning to beginning
- Duration: beginning to end
- Strength/Quality/Peak
- Resting tone/relaxation interval

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External tocodynamometer

**Contractions: External Toco**

Contraction can be measured from peak to peak. Here, contractions are every 2-3 mins.

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Montevideo Units

- Adequacy of contractions
  - **IUPC ONLY**
  - Number of ctx in 10 mins X mean amplitude (mm Hg)

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Montevideo Units

**Calculating MVUs**

Construction forces are usually reported in Montevideo Units (MVUs), which represent the total of the intensity of each contraction in a 10 minute period. MVUs > 200 are adequate for 90% of labors to progress.

- Baseline pressure (Hypotonic) ~ 20 mm Hg
- MVUs: 75+60+45+30 = 210 MVUs

(Notes that the baseline pressure was substituted from each reading.)
How often do I have to do this??

Intrapartum

<table>
<thead>
<tr>
<th>Patient Type</th>
<th>First Stage</th>
<th>Second Stage</th>
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<tbody>
<tr>
<td>Uncomplicated</td>
<td>30 min</td>
<td>15 min</td>
</tr>
<tr>
<td>Complicated</td>
<td>15 min</td>
<td>5 min</td>
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*Don’t forget to document your findings!

Limitations of EFM

- Poor interobserver and intraobserver reliability
- Uncertain efficacy
- High false-positive rate

Electronic Fetal Monitoring vs Intermittent auscultation

- There are no RCT to document that EFM is superior therefore it is acceptable that an uncomplicated patient could opt for IA
- However, this is hospital and staff dependent, as IA is very “labor intensive”
  - ACOG recommends: q15 min in active phase of latent labor and at least q5 min in second stage

Reading EFM

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- Decelerations

Contractions

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Objectives

- Quick Review
- Definitions
- Management considerations
- Practice
Abnormal baseline

- Tachycardia  > 160 bpm
  - Maternal fever & drugs
- Bradycardia  < 110 bpm
  - Maternal drugs, hypothyroidism, SLE
  - Fetal heart block

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Changes in Variability

- Hypoxic causes
  - Tachysystole
  - Abruptition
  - Maternal hypotension
- Non-hypoxic causes
  - Sleep cycle
  - Prematurity
  - Cardiac arrhythmias
  - Medications (narcotics)

Acceleration

- Visually apparent abrupt increase in the FHR
  - Onset to peak <30 seconds
  - Prolonged acceleration lasts 2 -10 minutes, longer than 10 minutes is a baseline change

> 32 weeks 15 x 15
< 32 weeks 10 x 10
Decelerations

- Early
- Late
- variable
- prolonged

Early Deceleration

- Visually apparent, usually symmetric, gradual decrease and return of the FHR associated with a uterine contraction
  - Onset to nadir >30 seconds
  - Nadir of the deceleration occurs at the same time as the peak of the contraction
  - Fetal head compression

Variable Deceleration

- Visually apparent abrupt decrease of FHR below baseline
  - less than 30 seconds from onset to nadir
- Decrease must be:
  - > 15 bpm below baseline
  - duration > 15 seconds but < 2 minutes
- Variable association with contractions
- Cord compression

Variable Deceleration

- Configuration depends upon degree of occlusion
- Partial occlusion
  - occlusion of umbilical vein only
  - reduction of fetal blood return
  - hypotension stimulates baroreceptors with FHR acceleration
Variable Deceleration

• Complete occlusion
  – occlusion of umbilical vein and artery
  – fetal hypertension resulting in
    • baroreceptor mediated decel (first 15-20 sec)
    • followed by chemoreceptor mediated decel (hypoxia, at 30 seconds)

Late Deceleration

• Visually apparent usually symmetric gradual decrease and return of the FHR associated with a uterine contraction
  – > 30 seconds from onset to nadir
• Deceleration is delayed in timing, with the nadir of the deceleration occurring after the peak of the contraction

Late Decelerations

• Fetal hypoxia causes CNS mediated cardiac deceleration reflex
• Myocardial depression secondary to metabolic acidosis
• Placental insufficiency
Deceleration pattern
- Defines the nature of the insult

Variability
- Characterizes the ability of fetus to tolerate the insult

Prolonged decelerations
- Visually apparent decrease in the FHR below the baseline
- 15 bpm or more, lasting 2 minutes or more but less than 10.
- If a deceleration lasts 10 minutes or longer, it is a baseline change

FHR Decelerations
- Depth and duration should be quantitated
  - Recurrent: ≥50% of ctx
  - Intermittent: <50% of ctx

Sinusoidal pattern
- Visually apparent, smooth, sine wave-like undulating pattern in FHR baseline with a cycle frequency of 3-5 per minute which persists for 20 minutes of more
Contractions

- 10 minute window averaged over a 30 minute period
- Normal: 5 contractions or less in a 10 minute window over a 30 minute window

Tachysystole

- > 5 contractions in 10 minutes averaged over 30 minute window
- Should also describe the presence or absence of associated decelerations
- Can be used for spontaneous or induced contractions


Tachysystole

Uterine hyperstimulation

- Uterus does not relax between contractions
- Resting uterine tone > 25 mm Hg
- Perfusion of intervillus space is compromised
- FHR decelerations secondary to lack of oxygen

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Fetal Metabolic Acidemia

Accelerations present and/or moderate variability → Unlikely risk of acidemia

Interpretation of FHR Patterns

• Patterns reflect the current acid-base status of the fetus
• Tracing patterns will change over time
• Cannot predict the development of cerebral palsy
• Three tier system
  – Category I, II, III

Category I = NORMAL

• Baseline rate: 110 – 160 bpm
• Baseline variability: Moderate
• Late or variable decels: Absent
• Early decels: Present or absent
• Accelerations: Present or absent
• Strongly predictive of normal acid-base status
• No action needed

Category III = BAD!!!!
Category III

- Recurrent late decels with absent variability
- Recurrent variable decels with absent variability
- Bradycardia with absent variability
- Sinusoidal pattern

Category II = everything else

Category II

- Baseline rate:
  - Bradycardia with mod/min variability
  - Tachycardia
- Baseline variability:
  - Minimal variability
  - Absent not accompanied by recurrent decels
  - Marked variability
- Accelerations:
  - Absent of induced accels after fetal stimulation

Categories

- Category I
  - Normal/strongly predictive of normal acid-base status
  - No action needed
- Category II
  - Indeterminate
  - Not predictive of abnormal acid-base status
  - Requires evaluation, increased surveillance
- Category III
  - Predictive of abnormal acid-base status
  - Requires prompt evaluation and intervention
Table 2. Various Intrauterine Resuscitative Measures for Category II or Category III Tracings or Both

<table>
<thead>
<tr>
<th>Goal</th>
<th>Associated Fetal Heart Rate Abnormality*</th>
<th>Potential Intervention (s)</th>
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<tbody>
<tr>
<td>Promote fetal oxygenation and improve uteroplacental blood flow</td>
<td>Recurrent late decelerations</td>
<td>Initiate maternal oxygen administration</td>
</tr>
<tr>
<td></td>
<td>Prolonged decelerations or bradycardia</td>
<td>Administer maternal oxygen administration, administer intravenous fluid bolus</td>
</tr>
<tr>
<td></td>
<td>Minimal or absent fetal heart rate variability</td>
<td>Reduce uterine contraction frequency, administer tocolytic medication (e.g., milrinone)</td>
</tr>
<tr>
<td>Relax uterine activity</td>
<td>Tachysystole with Category II or III tracing</td>
<td>Discontinue oxytocin or cervical ripening agents, administer tocolytic medication (e.g., nifedipine)</td>
</tr>
<tr>
<td>Minimize uterine cord compression</td>
<td>Recurrent variable decelerations</td>
<td>Initiate maternal expulsive efforts</td>
</tr>
<tr>
<td></td>
<td>Prolonged decelerations or bradycardia</td>
<td>Infiltrate amniotic fluid, if ruptured uterine cord is rent, elevate the presenting fetal part with thừa preparations are underway for operative delivery</td>
</tr>
</tbody>
</table>

*Given the side variation of FHR tracings in Category III, this algorithm is not meant to represent cause.